

Heat cost allocators for the determination of
the consumption of room heating radiatorsAppliances with electrical energy supply
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ICS 91.140.10

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Descriptors: Heating, HVAC system, heat cost allocator, energy consumption.

Heizkostenverteiler für die Verbrauchswernerfassung von Raumheizflächen;
Geräte mit elektrischer Energieversorgung**European Standard EN 834: 1994 has the status of a DIN Standard.***A comma has been used as the decimal marker.***National foreword**

This standard has been prepared by CEN/TC 171.

The responsible German body involved in its preparation was the *Normenausschuß Heiz- und Raumlufttechnik* (HVAC Standards Committee).**Amendments**

In comparison with DIN 4713-3, January 1989 edition, the following amendments have been made.

- a) This standard is largely based on the specifications of DIN 4713-3.
- b) The annex includes information and recommendations for heating systems to be equipped with heat cost allocators.

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DIN 4713-3: 1980-12, 1989-01; DIN 4714-3: 1980-12.

EN comprises 22 pages.

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English version

**Heat cost allocators for the determination of
the consumption of room heating radiators**

Appliances with electrical energy supply

Répartiteurs de frais de chauffage pour
enregistrer les valeurs de consommation
de surfaces de corps de chauffe; appareils
avec une alimentation en énergie électrique

Heizkostenverteiler für die Verbrauchs-
werterfassung von Raumheizflächen; Ge-
räte mit elektrischer Energieversorgung

This European Standard was approved by CEN on 1994-10-14.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Contents

	Page
Foreword	4
1 Introduction	4
2 Scope and general terms	4
3 Functional principle and measuring principle	5
4 Definitions	5
4.1 Reference condition	5
4.2 Reference counting rate	6
4.3 Temperature sensors	6
4.4 Measuring range of temperature sensors	6
4.5 Design flow temperature, design return temperature, mean design heating medium temperature	6
4.6 Upper temperature limit	6
4.7 Lower temperature limit	6
4.8 Start temperature	7
4.9 Displayed reading	7
4.10 Rated displayed reading	7
4.11 Counting rate	7
4.12 Nominal meter characteristic	7
4.13 Relative display deviation	7
4.14 Idle counting rate	7
4.15 Measuring period	7
4.16 c-value	7
4.17 Full utilization period	8
4.18 Rating factors	8
4.19 Transmission systems	9
4.20 Manufacturer	9
5 Requirements for the heat cost allocators	9
5.1 Requirements concerning temperature strain	9
5.2 Storage temperature	10
5.3 Start temperature	10
5.4 Idle counting rate	10
5.5 Temperature sensors	10
5.6 Calculator / Central unit	10
5.7 Auxiliary power supply	11
5.8 Overflow of the display	11
5.9 Resolution of the display	11
5.10 Function check	11
5.11 Maximum permissible errors	11
5.12 Ageing	12
5.13 Electrical, electrostatic and magnetic influences	12
5.14 Thermal influence on heat cost allocators operating on the single sensor principle	12
5.15 Thermal influence on heat cost allocators with a room temperature sensor	12
5.16 Thermal influence on other parts and components	12
5.17 Influence on transmission systems	12
5.18 Sealing	12
6 Requirements for use and installation	13
6.1 Temperature limits	13
6.2 Installation of sensors	13
6.3 Installation position of the sensors	13
6.4 Wire and signal cable installation	13
6.5 Conformity of instruments	13

7	Requirements for the rating	14
7.1	Resulting rating factor K	14
7.2	Rating factor K_Q	14
7.3	Rating factor K_C	14
7.4	c-value	14
7.5	Rating factor K_T	14
8	Requirements for maintenance and reading	14
9	Testing	15
9.1	General	15
9.2	Test documents	15
9.3	Test report	15
9.4	Test protocols	15
10	Test procedures	15
10.1	Construction	15
10.2	Sealing	15
10.3	Temperature durability	15
10.4	Error limits	16
10.5	Ageing	16
10.6	External influences	17
10.7	c-values, test procedure	17
10.8	c-values, test range	17
10.9	Rating factor K_Q	18
10.10	Rating factor K_C	18
11	Marking	18
Annex A (informative)		
Information and recommendations		19
A.1	Heating systems	19
A.2	Recommended field of application	19
A.3	Heat emission not controllable by the consumer	19
A.4	Additional corrections	20
Annex B (informative)		
Bibliography		22

Foreword

This European Standard has been prepared by the Technical Committee CEN/TC 171 "Heat cost allocation", the secretariat of which is held by DIN.

This standard includes 2 informative annexes A and B. These parts of the standard are not binding.

This European Standard shall be given the status of a National Standard, either by publication of an identical text or by endorsement, at the latest by April 1995, and conflicting national standards shall be withdrawn at the latest by April 1995.

According to the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

1 Introduction

This standard defines heat cost allocators with electrical power supply, which serve to establish the consumption value of a room radiator. It also specifies the minimum requirements for construction, materials, production, installation, function and evaluation of the displayed readings established by these measuring devices.

This standard specifies test procedures to establish the compliance with the stated requirements and gives instruction for the manner and the extent of their realization.

2 Scope and general terms

Heat cost allocators in accordance with this standard are instruments for the registration of the thermal output of radiators in consumer units.

Consumer units are dwellings, office buildings, business premises or industrial plants in which the heat is supplied by a common central heating system or by a common district heating connection.

A complete grouping of consumer units is called an account unit.

It could be necessary to divide an account unit into groups of users, if an account unit comprises consumer units of different types (e.g. technically different types of heating systems or because of consumer behaviour e.g. industrial plants as opposed to private apartments).

Heat cost allocators only allow the determination of the heat consumption of each radiator in a consumer unit as a share of the total heat consumption of the account unit or user group (see clause 3). It is therefore necessary to determine this total heat consumption either by measuring the consumed fuel quantity or the amount of heat delivered (the latter e.g. by a heat meter).

The condition for correct use of heat cost allocators in accordance with this standard is that they are used in a heating system which

- at the time of installation of the heat cost allocators, corresponds to the state of the art and
- is operated in accordance with the state of the art (see annex A, A.1).

Heat cost allocators in accordance with this standard shall not be used for heating systems where the temperature limits are exceeded, where the rating factor for the thermal power, K_0 , is not clearly specified or where the heating surface is inaccessible. This applies e. g. to following heating systems:

- underfloor heating
- radiant ceiling heating
- flap-controlled radiators
- radiators with ventilators
- fan-assisted air heaters
- heating systems where the radiators attached thereto are operated by steam

3 Functional principle and measuring methods

Heat cost allocators in accordance with this standard are measuring devices for the registration of the temperature integral with respect to time. The temperature is the basis for the determination of the thermal output of the radiators on which the heat cost allocators are installed. Heat cost allocators in accordance with this standard with electrical power supply use one or more of the characteristic temperatures which determine the thermal output of the radiator surface to obtain their output. The non-rated displayed reading is the approximate value of the time integral of the measured characteristic temperature of the radiator or the time integral of the temperature difference between the radiator surface and the room.

The rated displayed reading is obtained from the non-rated displayed reading by multiplication by rating factors, particularly with those for the nominal thermal power of the radiator and those for the thermal contact between the surface and the sensors (see 4.18).

The consumption value is approximately proportional to the heat emitted in the measuring period from the heating surface and consumed by the user. The consumption value (see 4.10) is obtained either by reading off directly at the heat cost allocators or by later conversion of the non-rated displayed reading (see 4.9).

Thus the consumption value is a measuring result influenced by characteristics of the heat cost allocators, of the radiator, of secondary requirements and by factors of uncertainty of the rating factors and the installation. Accordingly the measuring deviations (measuring errors) of the recorded heat consumption are not only dependent on the heat cost allocator alone. Thus, heat cost allocators cannot be calibrated in the same way as heat meters.

Because of the described characteristics the measuring result is not related to physical energy units. The consumption value is non-dimensional. It is only a value relative to the sum of the consumption values of the account unit or of the group of users. A relative value of a measured consumption value which has been defined in that way has to be understood as a part of the total heat, consumed by the account unit or of the group of users. At the end of the measuring period, this value is established separately for every radiator. From the sum of all the consumption values of the radiators of a consumer unit, the above relative value will determine the part of the heat consumption of the respective consumer unit related to the total consumption of the account unit or the group of users.

Heat cost allocators consist of at least a case, sensors, calculator, display, power supply, installation and seal. The seal serves to protect against unauthorized manipulation. Each heat cost allocator is a functional unit. Its individual parts shall be manufactured in compliance with certain tolerances. Thus each part of a particular kind of heat cost allocator (type, make) function equally when used in the same way.

Heat cost allocators in accordance with this standard work according to one of the following measuring principles:

The single-sensor measuring principle utilizes one temperature sensor. The sensor records the temperature of the radiator surface or of the heating medium.

The two-sensor measuring principle utilizes two temperature sensors. One sensor measures the temperature of the radiator surface or of the heating medium, the second sensor measures the room temperature or a temperature in a defined relation to this.

The measuring principle using the logarithmic excess temperature measures with three sensors the flow and return temperatures of the heating medium and the room temperature.

4 Definitions

For the purpose of this standard, the following definitions apply.

4.1 Reference condition

For the purpose of determining the rating factors and the c-value, a reference condition shall be defined. The

reference condition can be freely selected within certain limits.

The reference condition of a radiator is as follows:

- upper flow inlet
- mean heating medium temperature: $t_m = 40\text{ °C to }60\text{ °C}$
- reference air temperature $t_L = (20 \pm 2)\text{ °C}$. It shall be measured 0,75 m above the floor and at a distance of 1,5 m from the heating surface in a test chamber with a stable climate.
- heating medium flow (water flow through the radiator) at $t_v / t_R / t_L = 90\text{ °C} / 70\text{ °C} / 20\text{ °C}$

where:

t_v is the flow temperature

t_R is the return temperature

4.2 Reference counting rate

The reference counting rate is the value of the counting rate related to the nominal meter characteristic (see 4.12) at reference condition (c-value equals zero). It serves to determine the rating factor K_c (see 4.18.2).

4.3 Temperature sensors

Temperature sensors consist of the sensor element and the sensor casing, which serves to protect the sensor element from mechanical influences and to conduct heat.

4.4 Measuring range of temperature sensors

The measuring range is the range within which the temperature sensors can be used for measurement. When using pairs of temperature sensors, which measure temperature differences, the measuring range is supplemented by the range of temperature difference.

4.5 Design flow temperature, design return temperature, mean design heating medium temperature

The design flow and return temperatures are the temperatures of the heating medium of the radiators required to reach the design indoor temperature in the heated rooms under steady state conditions at a heat load corresponding to a geographically determined design reference outside temperature. The mean value of the design flow temperature $t_{v,A}$ and the design return temperature $t_{R,A}$ is the mean design heating medium temperature $t_{m,A}$. This temperature is to be determined from the logarithmic mean value of the excess temperatures relating to the reference air temperature of 20 °C.

4.6 Upper temperature limit

The upper temperature limit t_{max} is the maximum mean design heating medium temperature of the radiators in the heating system at which the heat cost allocator may be used. It is determined on basis of the materials and parts used.

4.7 Lower temperature limit

The lower temperature limit t_{min} is the lowest mean design heating medium temperature of the heating system

at which the heat cost allocator is permitted to be used. For single pipe heating systems, this is the mean design heating medium temperature of the last radiator in the string or, as substitute, the design return temperature of the string. The lower temperature limit depends on the metering principle.

4.8 Start temperature

The start temperature t_2 is the mean heating medium temperature in the radiator, in the partial load range with the mass flow corresponding to the reference condition, at which the heat cost allocator starts counting.

4.9 Displayed reading

The displayed reading generally is the measuring value produced by the heat cost allocator which can be read off as a numerical value at the display device. If this value is not equal to zero at the beginning of the measuring period (see 4.15), the displayed reading relative for the heat cost calculation is determined from the difference between the numerical values at the end and the beginning of the measuring period.

The reading may be an unrated or a rated value (see 4.10).

4.10 Rated displayed reading

The rated displayed reading is the displayed reading rated by the rating factors according to 4.18.

4.11 Counting rate

The counting rate R is the progression of the display per unit of time.

4.12 Nominal meter characteristic

The meter characteristic is the intended relation between the counting rate and, according to measuring principle, the temperature or the temperature difference.

4.13 Relative display deviation

The relative display deviation is the difference between the actual display counting rate and the nominal counting rate related to the nominal display counting rate.

4.14 Idle counting rate

The idle counting rate is the counting rate at room temperature, without thermal output from the radiator.

4.15 Measuring period

The measuring period is the period of time in which the heat consumption is recorded without interruption.

4.16 c-value

The c-value expresses the degree of thermal coupling between the temperature sensors and the temperatures to be recorded. It is defined as a temperature difference ratio according to following equation:

$$c = 1 - \frac{\Delta t_s}{\Delta t} \quad (1)$$

where:

Δt_s is the temperature difference of the sensors, e.g. $t_{HS} - t_{RS}$ or Δt_{ins}

Δt is the heating medium excess temperature $t_m - t_L$ or Δt_{in}

where:

t_{HS} is the temperature of the radiator sensor

t_{RS} is the temperature of the room temperature sensor (for heat cost allocators without room temperature sensor: $t_{RS} = t_L$)

t_m is the mean heating medium temperature

t_L is the reference air temperature (see 4.1)

t_v is the flow temperature of the radiator

t_R is the return temperature of the radiator

Δt_{in} is the logarithmic excess temperature of the heating medium according to:

$$\Delta t_{in} = \frac{t_v - t_R}{\ln \frac{t_v - t_L}{t_R - t_L}} \quad (2)$$

Δt_{ins} is the logarithmic excess temperature of the temperature sensors

If the temperature characteristics of the sensors or pairs of sensors used are known, then the measuring signals or counting rates assigned to them can also be used for measuring the stated temperatures or temperature differences.

4.17 Full utilization period

The full utilization period of the radiator thermal output is the quotient of the heat emitted by the radiator in a calendar year and the nominal thermal output (see 4.18.1). It has the unit of hours/year.

4.18 Rating factors

The following rating factors convert the displayed readings of the individual heat cost allocators into rated displayed readings in a form suitable for the calculation of the consumption costs.

4.18.1 Rating factor K_0 for the thermal output of the radiator

The rating factor K_0 is the (non-dimensional) numerical value of the nominal thermal output (in watts) of the radiator.

The nominal thermal output is the thermal output of a radiator operated at flow temperature, return temperature and air temperature of 90 °C, 70 °C and 20 °C in a test chamber with a stable temperature. The air temperature has to be measured 0,75 m above the floor at a distance of 1,5 m from the heating surface. If the nominal heat output of the radiator was established under other temperature conditions, it shall be

converted into the above mentioned conditions¹⁾.

4.18.2 Rating factor K_c for the thermal coupling to the temperature sensors

The rating factor K_c takes into account that the thermal coupling between the temperature of the heating medium and the temperature sensors varies according to the different types of radiator surfaces¹⁾.

K_c is the quotient of the reference counting rate and the counting rate at the temperatures of temperature sensors on the radiator operated at reference condition:

$$K_c = \frac{R_{\text{reference}}}{R_{\text{rating}}} \quad (3)$$

4.18.3 Rating factor K_T for rooms with low design indoor temperatures which deviate from the basic reference air temperature

The rating factor K_T takes account of the change of the thermal output and the change of the temperature of the sensors where heat cost allocators according to the single-sensor measuring principle are used at design indoor temperatures less than the reference air temperature at the reference condition.

4.18.4 Resulting rating factor K

The resulting rating factor K is the product of the individual rating factors:

$$K = K_0 \times K_c \times K_T \quad (4)$$

4.19 Transmission systems

Transmission systems are defined as arrangements used to transmit signals between subassemblies of the heat cost allocator which are located separately.

4.20 Manufacturer

A manufacturer according to this standard is the person or company responsible for the supply and installation of the heat cost allocator.

5 Requirements for the heat cost allocators

5.1 Requirements concerning temperature stress

Brief occurrence of t_{max} of the mean heating medium temperature, shall cause no impairment of the proper function of a heat cost allocator or its components, installed and ready for service on the radiator. This is valid similarly for heat cost allocators mounted on other surfaces e.g. on pipes.

For components not attached to the heating surfaces, ambient temperatures between 0 °C and 50 °C shall not cause any functional anomalies.

¹⁾ If a special type of radiator connection is used which deviates from the reference conditions described in 4.1 or if the casings are connected to the radiator in such a way that they cannot be changed by the user, the rating factors K_0 and K_c shall be determined under these conditions.

5.2 Storage temperature

The construction of all components shall be such that storage temperatures of between - 25 °C and + 60 °C shall not cause any functional disturbances.

5.3 Start temperature

Heat cost allocators according to the single sensor principle, without room temperature start sensor shall, on a radiator with $c \leq 0.10$ at a heating medium flow corresponding to the reference condition (see 4.1) and a room temperature of 20 °C, start counting at the temperature t_z according to the equation 5 and 6:

$$\text{for } t_{\min} \geq 60 \text{ °C} : t_z \leq 0,3 \times (t_{\min} - 20 \text{ °C}) + 20 \text{ °C} \quad (5)$$

$$\text{for } 55 \text{ °C} \leq t_{\min} < 60 \text{ °C} : t_z \leq 28 \text{ °C} \quad (6)$$

For heat cost allocators with room temperature sensor, the criterium for the start temperature in equation 7 is valid for all measuring principles (see clause 3):

$$t_z - t_L \leq 5 \text{ K} \quad (7)$$

Where different types of radiators are used within one account unit, t_z for the individual heat cost allocators may differ up to 10 % ($t_{\min} - 20 \text{ °C}$). The difference shall not exceed 5 K.

5.4 Idle counting rate

At room temperatures of up to 27 °C, the idle counting rate shall not exceed 1 % of the nominal counting rate at a heating medium excess temperature of $\Delta t = 60 \text{ K}$ with a liquid flow corresponding to the reference condition and with $c \leq 0,1$.

5.5 Temperature sensors

The mechanical strength and thermal durability of the sensor casing shall be sufficient to prevent deformations during installation, operation and dismantling for inspection purposes, which impair the intended function of the sensor element.

For inspection purposes, the instruments or their components shall be capable of being dismantled in such a way that checking the requirements as specified in 5.12 is possible.

The temperature sensors shall satisfy specified environmental conditions which include a lower temperature limit of + 5 °C, an upper temperature limit of at least $t_{\max}$ (see 4.6) and an annual mean value of the relative air humidity of $\leq 65 \text{ \%}$.

5.6 Calculator / Central unit

The mechanical design shall guarantee protection against the penetration of solid foreign bodies and keep out tools, wires and similar objects. It shall further guarantee that water dropping vertically onto it has no damaging effect.

As test requirement for the mechanical strength is to apply an oscillating loading at a frequency of 10 Hz to 55 Hz with an acceleration of 20 m/s^2 .

The calculator / central unit shall satisfy specified environmental conditions which include a lower temperature limit of 0 °C, an upper temperature limit of 50 °C and an annual mean value of the relative air humidity of $\leq 65 \text{ \%}$.

5.7 Auxiliary power supply

In the case of a battery power supply, the capacity of the battery shall be adequate to ensure trouble-free operation for at least three months more than the period for changing the battery as stipulated by the manufacturer. A minimum battery capacity of 15 months shall be ensured. If the battery voltage drops during this period, the error limits in accordance with 5.11 shall not be exceeded.

5.8 Overflow of the display

Within two consecutive measuring periods (a measuring period usually comprises 12 months), no overflow of the meter shall occur which could remain unnoticed. A full utilization period (see 4.17) of 1500 hours per year at the highest radiator thermal output permitted by the manufacturer is assumed. This requirement also applies to design temperatures higher than $t_v / t_R = 90\text{ °C} / 70\text{ °C}$.

5.9 Resolution of the display

After 24 hours operation on a sectional radiator of 1 kW nominal thermal output (see 4.18.1) at a partial load thermal output corresponding to a logarithmic excess temperature of 35 K and a heating medium flow corresponding to the reference condition (see 4.1) the displayed reading shall be at least 10 .

5.10 Functional check

A functional check shall be made either during the annual service of the allocator or by continuous automatic self-testing of the unit during the entire operating period.

The function check shall provide evidence for the proper function of the following parts of the heat cost allocator:

power supply

display

calculator

sensors

external signal transmission systems

5.11 Maximum permissible errors

The relative display deviation (see 4.13), as a function of the heating medium excess temperature Δt at a heating medium flow corresponding to the reference condition (see 4.1) and $c \leq 0,1$, shall not exceed the following maximum permissible errors:

for	$5\text{ K} \leq \Delta t < 10\text{ K}$	:	12 %
for	$10\text{ K} \leq \Delta t < 15\text{ K}$	:	8 %
for	$15\text{ K} \leq \Delta t < 40\text{ K}$	:	5 %
for	$40\text{ K} \leq \Delta t$	:	3 %

In systems with exchangeable components, this requirement shall also be met when the components are exchanged.

5.12 Ageing

In long term use, the errors, including the effect of a discharged battery, shall not exceed twice the error limits stated in 5.11.

5.13 Electrical, electrostatic and magnetic influences

The counting rate, at the reference condition with the lowest permissible operating voltage, shall be altered no more than 5 % by the following influences on the calculator, sensors and connection cables:

- a) Magnetic alternating field with a field strength of 60 A/m at a frequency of 50 Hz. The field strength applies for the field before placing the test sample in the field.
- b) Electromagnetic radiation with a field strength of 10 V/m at frequencies from 100 kHz to 160 MHz. The field strength applies for the field before placing the test sample in the field.
- c) Magnetic d.c. fields which can be generated by a permanent magnet with a field strength of 60 kA/m at a distance of 0,5 cm from the front plane
- d) Electrostatic discharges of 8 kV from a condenser of 150 pF, relating to a discharge resistance of 330 Ω onto the instrument ready for operation.

5.14 Thermal influence on heat cost allocators operating on the single sensor principle

The counting rate shall be reduced by no more than 2 % by a temperature increase of 15 K on the front surface, when measuring on a radiator with $c \leq 0,1$, operated at the maximum permissible temperature $t_{\max}$ (see 4.6) and a heating medium flow corresponding to the reference condition (see 4.1).

5.15 Thermal influence on heat cost allocators with a room temperature sensor

By measurement on a similar radiator in the same operating conditions as specified in 5.14, at a room temperature of 20 °C, a temperature increase of the heat cost allocator or its individual components shall not cause a reduction in counting rate greater than that which would be caused by an increase of the room temperature from $t_L = 20$ °C to $t_L = 25$ °C.

5.16 Thermal influence on other parts and components

When parts and components other than the temperature sensor operate in the temperature range from 0 °C to 50 °C, the counting rate shall not change by more than 0,2 % from that at 20 °C in the reference condition of the temperature sensors ($c = 0$).

5.17 Influence on transmission systems

Transmission systems shall be designed so that by measurement on a similar radiator in the similar operating condition as defined in 5.14, influences do not change the counting rate by more than 1 % of the nominal counting rate.

Influences can be, for instance:

Ambient temperature, transient temperature changes, air humidity, electromagnetic fields, electrostatic discharges and interference voltages on supply mains or signal cables.

5.18 Sealing

All components which have a possible influence on the measurement results shall be provided with a seal or other type of protection constructed to prevent access to the instrument without visible damage.

6 Requirements for use and installation

6.1 Temperature limits

Heat cost allocators in accordance with this standard may be used in heating systems with design heating medium temperatures $t_{m,A}$ (see 4.5) between the upper temperature limit t_{max} (see 4.6) and the lower temperature limit t_{min} (see 4.7):

$$t_{min} \leq t_{m,A} \leq t_{max}$$

For heat cost allocators which operate according to the single sensor principle, is $t_{min} \geq 55 \text{ }^{\circ}\text{C}$.

6.2 Installation of sensors

The installation of sensors shall be reliable and resistant to manipulation. An adhesive shall only be used if removal is to be impossible without clearly visible damage to the sensor and if the uniformity of the c-values is not impaired.

6.3 Installation position of the sensors

The installation position shall be chosen to give a suitable relation between the displayed reading and the heat emission of the radiator over a sufficiently large operating range. The manufacturer shall provide evidence of this.

6.4 Wire and signal cable installation

The regulations which apply for the safety and the freedom from disturbance of electricity, signalling and communication installations shall be complied with when installing wires and signal cables.

6.5 Conformity of instruments

Within one account unit (or, if advance allocation of heat consumption is made, within one user group) it is only permitted to use heat cost allocators of the same manufacture and the same type²⁾, with uniform rating systems. Each type of heat cost allocators shall be identifiable.

7 Requirements for the rating

The rating factors K_C and K_T shall be specified to a minimum of two decimal places.

7.1 Resulting rating factor K

K_0 shall always be included in the resulting rating factor K . K_C and K_T are to be included depending on the particular case. Each heat cost allocator shall be visibly marked with the resulting rating factor or a figure proportional to it or the user shall be provided with a note containing this information.

Each heat cost allocator shall be provided with a serial number or with the figure proportional to the resulting

²⁾ Heat cost allocators with different heat conducting casing parts (back plates) for adaption to various types of radiators are not considered as different types of devices. Also variants of the same type of devices - e.g. compact versions and versions with radiator temperature sensors which are located separately - are not considered as different types of devices.

rating factor.

For each heat cost allocator, rating with the resulting rating factor K is required which shall enable registration of the rated thermal output of the radiator in steps of maximum 60 W, or 5 % in the thermal output range up to and including 3000 W, and 3 % in the thermal output range above 3000 W.

7.2 Rating factor K_Q

Rating using K_Q shall be carried out based on the radiator which is actually installed.

7.3 Rating factor K_C

The rating factor K_C shall be used if this factor gives differences of more than 3 % within one account unit.

7.4 c-value

The c-value in accordance with the definitions in 4.16 shall be determined. Combinations of radiators and heat cost allocators with $c > 0,67$ (two sensor measuring principle) or $c > 0,3$ (single sensor measuring principle and measuring principles with room temperature sensors which are located separately), measured at reference condition, are usually not permitted. Exceptionally, c-values of up to 0,72 (two sensor measuring principle) or $c > 0,4$ (single sensor measuring principle and measuring principles with room temperature sensors which are located separately) are permitted within one account unit provided that the surface in question is not more than 25 % of the entire heated surface, or if the mean design heating medium temperature is higher than 80 °C.

Installation is only permitted on radiators for which the c-value is known at the time of heat cost invoicing.

Should the determination of the c-value be based on definitions other than those in 4.16, these definitions shall be stated in full detail. In such case it shall be ensured that one type of heat cost allocator is treated uniformly and that it is possible to relate the c-value to that defined in 4.16.

7.5 Rating factor K_T

K_T shall be used for design room temperatures of less than 16 °C.

8 Requirements for maintenance and reading

As part of the reading process, the heat cost allocators shall be checked with respect to their general condition, durability of the installation, integrity of the seal and any damage.

As part of the annual monitoring process, a function check shall be carried out as stated in 5.10. The result of this shall be recorded. Batteries shall be given an identification marking which shows the date of manufacture or installation. If the batteries are designed to last more than one year, the date for the next exchange of batteries shall also be shown.

Before each exchange of batteries, the terminals or other connecting elements shall be examined to see whether there has been any oxidation, crystal formation or soiling, which would lead to increased contact resistance.

After the batteries have been exchanged, the battery chambers shall be sealed.

The resulting rating factor or the figure proportional to it according to 7.1 shall be noted in the record for each heat cost allocator. If non-rated displayed readings are used, the serial number shall be stated in addition. When using rated displayed readings, the serial number can be stated instead of the resulting rating factor.

9 Testing

9.1 General

The testing shall be carried out in accordance with clause 10, also checking the requirements of clauses 5, 6, 7 and 8 which are not dealt with in clause 10. The following tests shall be carried out by an authorized test laboratory.

9.2 Test documents

The documents required for the test, the test certificates, documentation, calculations, construction drawings and instructions for installation, etc., shall be provided by the applicant.

9.3 Test report

A report of the test has to be prepared which shall contain the following points with reference to clause 10:

- a) Test laboratory
- b) Applicant
- c) Manufacturer
- d) Description of appliance, specification of the appliances belonging to the tested type
- e) Field of application
- f) Test results
- g) Date
- h) Signature of the person responsible for the test

9.4 Test protocols

The test protocols shall explain the various tests and present the results. They shall be attached to the test report.

10 Test procedures

10.1 Construction

The conformity of the equipment with the construction drawings shall be checked visually or eventually by measurement, if necessary.

10.2 Sealing

The function and construction of the sealing, or of an alternative type of protection if provided for this purpose, shall be verified by a visual inspection.

10.3 Temperature durability

A batch of 5 complete heat cost allocators of each type shall be tested for 24 hours in a heating chamber at

a temperature 5 K above the upper temperature limit t_{max} (see 4.6). The compliance with the requirement in 5.1 shall be tested for the error limits in one of the test points in accordance with 10.4 before and after the above test.

10.4 Maximum permissible errors

A batch of 5 instruments shall be used to verify the measurement principles given by the manufacturer, and the nominal meter characteristic. This shall be carried out on a radiator with $c \leq 0,1$ at a heating medium flow corresponding to the reference condition (see 4.1) and a heating medium excess temperatures (Δt) of 60 K, 30 K, 12 K and 8 K, $\pm 1,5$ K based on a room temperature of 20 °C, but with a minimum of 1 K above the excess temperature of the start temperature, $t_2 - t_1$. Reproducible installation of the instrument shall be ensured. This can be proved by measuring the surface temperature on the outside of the casing of the heat cost allocator at points that provide heat contact between the temperature sensor and the radiator or the ambient air. The manufacturer shall indicate the temperatures to be expected at these locations.

At a heating medium excess temperature of 30 K, the above test shall be carried out with three different resulting rating factors with the ratio 1 : 2 : 4. Five heat cost allocators shall be tested with each rating factor. The error limits shall be checked using the displayed readings related to the lowest value of the used resulting rating factors as a check of the intended resulting rating factors.

For heat cost allocators which have temperature sensors mounted outside the casing, the test on the reference radiator may be replaced by a test in which the temperature sensors are immersed in temperature controlled baths.

The error limits in 5.11 shall not be exceeded by any of the test specimens.

10.5 Ageing

The test procedure for ageing shall be carried out on five operative allocators, with known meter characteristic, by exposing them to 300 temperature cycles of a maximum period of 100 minutes each. The ageing can be carried out

a) In a heat chamber

A temperature cycle is created by slowly heating the heat cost allocators over a maximum period of 45 minutes, up to a temperature of $[0,7 \times (t_{max} - 20 \text{ °C}) + 20 \text{ °C}] \pm 2 \text{ K}$ and then by cooling to $(25 \pm 2) \text{ °C}$.

b) On an electrically heated, oil-filled radiator

In this case, the heat cost allocators shall be fitted at the installation position specified by the applicant. A temperature cycle shall be created by slowly heating the radiator, over a maximum period of 45 minutes, to a surface temperature at the installation position, corresponding to the upper temperature limit t_{max} (see 4.6) $\pm 2 \text{ K}$ and then by cooling to $(25 \pm 2) \text{ °C}$.

For allocators with sensors which are located separately from the calculator, the temperature sensors shall be heated during the temperature cycles up to the temperature $t_{max} \pm 2 \text{ K}$.

Components (central unit, calculator, etc.) which are not mounted on the radiator shall be heated in the heating chamber to a temperature of $(50 \pm 2) \text{ °C}$, and then cooled to $(25 \pm 2) \text{ °C}$.

A subsequent test shall be carried out in accordance with 10.4, at one of the temperature points there stipulated. In this test no more than twice the value of the error limits in accordance with 5.11 shall be exceeded after completion of ageing. If the errors caused by the ageing process are not systematic (e.g. drift in the same direction), the test samples shall be exposed to a further 300 temperature cycles, after which the test shall be repeated.

10.6 External influences

The heat cost allocators shall be tested for conformity with the requirements set out in 5.13, 5.14, 5.15, 5.16 and 5.17. The test according to 5.15 shall be carried out for allocators which have room temperature sensors which are located separately by heating these room temperature sensors with maximal 25 W to a maximum temperature of 50 °C.

The test in 5.16 shall be carried out at the ambient temperatures of 0 °C and 50 °C.

10.7 c-values, test procedure

The testing of the c-values shall be carried out at the reference condition.

A batch of 3 heat cost allocators of each type shall be examined under identical test conditions. The installation positions and instructions provided by the applicant shall be observed. In this test, the temperatures or measuring signals corresponding to the definitions in 4.16 shall be measured, and the c-values calculated on this basis.

The test shall be conducted as follows:

Laboratory measuring instruments shall be used to measure the sensor temperatures, or if the characteristic curves of the sensors are known, the sensor signals shall be taken directly from the heat cost allocator.

The difference between the individual c-values of the installed heat cost allocators shall not exceed 0,02.

10.8 c-values, test range

The c-values for the following seven basic radiator types shall be determined by measurement:

- a) cast-iron column radiator
- b) steel plate column radiator
- c) vertical profile panel radiator
- d) non-profile panel radiator
- e) column pipe radiator
- f) pipe register radiator
- g) panel radiator with horizontal water flow.

If the applicant submits c-values for these radiators, the test laboratory shall compare these values with the results of its own measurements.

For the installation on other radiators, whose c-values have not been established through the measurements carried out on the seven basic radiators, the values shall be submitted by the applicant to the test laboratory for confirmation. The test laboratory shall ascertain the accuracy of the submitted c-values by remeasurement of a sample of 3 % of the provided c-values.

The c-values submitted by the applicant shall unsystematically deviate by no more than $\pm 0,02$ from the values obtained from the test laboratory's measurements. In addition, systematic deviations are permissible, provided that they do not alter the rating factor K_c by more than $\pm 3 \%$.

10.9 Rating factor K_0

The test shall be made with reference to a table, supplied by the applicant, containing the existing rating factors. The graduations in the table shall be used to calculate whether each thermal output of the radiators is recorded with the accuracy required in 7.1.

Conformity with the accuracy and the application of the rating factors K_0 shall be verified based on appropriate documentation provided by the applicant.

10.10 Rating factor K_c

Evidence concerning knowledge to and application of the rating factors K_c shall be provided by the applicant.

11 Marking

The heat cost allocator shall be visibly marked with the following data :

- type of heat cost allocator
- serial number or resulting rating factor or a figure proportional to it (see 7.1)
- t_{min} , t_{max}

Annex A

(informative)

Information and recommendations

This annex includes information and recommendations for the condition of the heating system (A.1), for the field of application of various principles of heat cost allocation (A.2), it includes recommendations for dealing with heat dissipation which cannot be controlled by the consumer (A.3) and references to additional corrections (A.4).

A.1 Heating systems

It is recommended that heating systems, to be equipped with heat cost allocators, have the following properties:

- a) Radiators should be equipped with controlling devices to be operated by the user (e.g. thermostatic valves).
- b) A correctly adjusted central controller with outdoor temperature sensor should be applied to control the flow temperature.
- c) The heating system should be adjusted hydraulically to obtain heating medium flow rates according to the design parameters.
- d) The size of the radiators should be calculated with respect to the temporarily reduced heating of adjoining rooms and consumer units.

The recommendation in a) should always be observed, as it is regarded as a necessary supplementary requirement when measuring the heat consumption. The recommendations in b) and c) are intended to minimize the errors in the heat cost allocation. The recommendation in d) should ensure sufficient heating.

A.2 Recommended field of application

Table A.1 gives information about the recommended field of application for various principles of heat cost allocation. The table reduces the field of application more than this standard itself, in order to reduce the level of allocation errors. It is based on investigations like [1]³⁾ and the herein chosen reference condition should be noted.

A.3 Heat emission not controllable by the consumer

The heat emission from pipes which go through the consumer unit, which cannot be controlled by the consumer should be taken into consideration when calculating the cost allocation, if the amount of heat, dissipated this way, essentially influences the accuracy of allocation⁴⁾. The assumption is, that the recommendations in A.1 are fulfilled.

³⁾ See annex B [1]

⁴⁾ See e. g. annex B [2]

A.4 Additional corrections

A.4.1 Within the context of heat cost invoicing, additional correction factors which are in accordance with national legislation are permissible, especially if they are not of a metrological nature.

A.4.2 If the flow temperature of a single pipe heating system is more than 95 °C or the design difference between the flow and the return temperatures of the whole line exceeds 20 K, the following additional rating factor K_E may be applied for heat cost allocators of the evaporation type, for each radiator, if this is laid down by national regulations.

$$K_E = (K_{E,AL} - 1) \times 0,35 + 1 \quad (7)$$

where $K_{E,AL} = (v_{AN}/v_{HK}) \times (\Delta t_{HK} / \Delta t_{AN})^n \quad (8)$

where:

v_{HK} is the evaporation rate at design conditions for the radiator in question at a measuring liquid level corresponding to zero on the scale

v_{AN} is the evaporation rate as above, calculated on a radiator of the same type, with the design flow and return temperatures of the heating system

Δt_{HK} is the design excess temperature of the heating medium for the radiator in question

Δt_{AN} is the excess temperature of the heating medium, calculated on the basis of the design flow and return temperatures of the heating system

n is the exponent of the radiator part load characteristic

For single pipe systems, where the radiators in a line are dimensioned for heat requirements deviating not more than approx. 50 %, it is permitted to check the temperature limits in accordance with 6.1 and to determine the values v_{HK} and t_{HK} assuming a linear temperature distribution between the radiators in the whole line (see annex B [3]).

Table A.1: Recommended field of application for heat cost allocators based on the evaporation principle (HKVV) and based on electrical power supply (HKVE)

+ = suitable - = unsuitable

1)	heating system	user on the line	pipe installation	temperature design 2) °C	HKVV class 3)		HKVE			
					A	B	single-sensor		multi-sensor	
							Komp	FF	Komp	FF 4)
a	design range low temperature			$t_{m,A} < 55$	-	-	-	-	+ ⁵⁾	+ ⁵⁾
				$55 \leq t_{m,A} < 60$	-	+	+	+	+	+
	design range above low temperature			$60 \leq t_{m,A} < 85$	+	+	+	+	+	+
				$85 \leq t_{m,A}$	+ ⁶⁾	-	+ ⁶⁾	+	+ ⁶⁾	+
b	single pipe	1			+	+	+	+	+	+
		> 1	horizontal		-	-	+	+	+	+
			vertical	$t_{v,A} \leq 95$ and $\Delta t_A \leq 20$	+ ⁷⁾	+ ⁷⁾	+	+	+	+
				$t_{v,A} > 95$ or $\Delta t_A > 20$	+ ⁸⁾	+ ⁸⁾	+	+	+	+
	double pipe				+	+	+	+	+	+

1) The requirements a and b have to be fulfilled.

2) $t_{m,A}$ mean design heating medium temperature on the radiator
 Δt_A design temperature drop of the single pipe line
 $t_{v,A}$ design flow temperature of the heating system

3) HKVV - class A: counting ratio < 12 or nominal evaporation < 60 mm
 HKVV - class B: counting ratio ≥ 12 and percentage of water in the measuring liquid $\leq 4\%$ and nominal evaporation ≥ 60 mm

4) Komp = compact heat cost allocator, FF = heat cost allocators with remote sensors

5) appliance-dependent lower temperature limit shall be observed.

6) appliance-dependent upper temperature limit shall be observed.

7) K_E may be used.

8) K_E shall be used.

Annex B
(informative)

Bibliography

- [1] Zöllner, G. und Römer, U.: Eine verbesserte Anwendung des Verdunstungsprinzips bei der Neuentwicklung von Heizkostenverteilern ohne Hilfsenergie. FWI 18 (1989), H 1, page 65 - 71
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